A HISTORY AND INVESTIGATION INTO THE FLUCTUATIONS OF *POLYGONIA C-ALBUM* L.: THE COMMA BUTTERFLY

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(*Concluded from p. 27*)

Climate

In entomological folklore it has been said that "to see many *Polygonia c-album* L. in the spring fortells a good year for butterflies" (Pard, 1980). More likely, it was also said that sunless summers greatly reduced the Comma's numbers (Frohawk, 1914) and that "a conjunction of unusually severe winters, and wet summers" caused disappearances (Dale, 1890) – this was again proposed more recently (Dennis, 1977) – and that the seven consequecutive wet years from 1875 to 1881 combined with the severe winter of 1880/1 caused decline (Dale, 1890). It has been shown that the species benefits from warm weather from May to September in part of Finland (Nyland) (Ekholm, 1975); it has also been intimated that the lower temperatures and less sunshine over the summer months endured in this country between 1870 and 1920 caused the decline of the Comma (Turner, 1986). One shrewd observer thought that the 20th century phenomena "only a temporary expansion of range due to fine summers and mild winters. . . . in spite of the severe frosts in May, the Comma seems to be even more abundant this season" (Bagnall-Oakeley, 1935). The foremost authority on *c-album* in early years was quite specific and said that "the finest specimens I have ever bred have been when very early warm springs have tempted the butterflies out, and ova being obtained and hatched, the larvae have been subjected to a return of cold unseasonable weather, and have fed up slowly. If cold came before the ova hatched they perished, if not placed in a warm room" (Hutchinson, 1896). Other experts were less definite and thought that the decline was caused by "some subtle and unnoticed change of climate" (Barrett, 1893). Thus there has been a consensus that, like *A. crataegi* which suffered large losses after wet Septembers (Pratt, 1983) and *L. camilla* whose range fluctuated with June temperatures (Pollard, 1979), this species is unusually affected by prevailing weather – in favourable seasons occurring in abundance in three broods and in adverse seasons occurring in an apparently single autumnal brood as a rarity. The decline of *c-album* has other similarities with that of *A. crataegi*; both enjoyed similar geo-

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graphical distributions in Great Britain and Europe and both lost colonies throughout the 19th century with sudden accelerating declines after about 1870. Indications might be gained from the fact that the insect mainly retreated to the hop-growing areas where "the situation had to be sheltered from cold winds, yet airy; moist but not wet; its climate as gentle and warm as could be found in England" (Mathias, 1959).

Examining the monthly, seasonal, annual, and decadal weather records (Brody, 1916; Central Statistical Office, 1940-1985; Glasspoole & Hancock, 1936; Manley, 1974; Meteological Office, 1952; Nicholas & Glasspoole, 1932) from the 17th century to date, there is no evidence that snow and, surprisingly, sunshine and rainfall, is involved in the fluctuations of this butterfly. There is only one significant short-term climatic coincidence with the years when *c-album* was uncommon – seasons of comparative rarity were usually preceded by a warm February, followed by overall low April to June temperatures, with the first and last mentioned months having the best individual correlations. The insect suffered sudden drops in numbers, or was unusually infrequent, in 1813, 1816, 1874, 1876, 1877, 1882, 1884, 1885, 1894 and 1913 – in every case except 1877 June was a cold month, and except for 1816 every February was warm. Despite some similarity with Mrs. Hutchinson's observations, there is no further relationship with the month of February. In the longer term, from 1811 to 1825 inclusive there were only three seasons which enjoyed warm June's and, 1877 and 1878 apart, there was a unique period of such weather from 1871 to 1886 inclusive, and more followed. Excluding 1905, there were no warm June's from 1901 to 1909 and, excluding 1925, from 1922 to 1929. More favourable and varied temperatures during this month then followed for many years. Over the present decade the first two June temperatures were average or less and the following three all above average. However, a cold June did not preclude a season of abundance, although warm months did predominate by a ratio of seven to three in those years of high numbers listed earlier. The trends in cold June's were matched by the seasonal figures for Spring (March/April/May); there was only one cold Spring during the 1840's but eight over the following decade. Excluding the mid 1890's, from 1876 to 1910 there were only two Springs with much above average temperatures (1659 to 1973), and most were cool; but from 1918 to mid-century a warmer regime prevailed – from 1933 to 1950 only one Spring was really cold (1941). Even after the middle of this century until the present decade there have been only eight cold Springs and a dramatic rise in these temperatures took place in 1981 and 1982 when the highest Spring temperatures for 20 years were recorded. This short period coincided with an unprecedented rise in numbers in northern districts, accompanied by territorial gains. "Temperature produces its results on the abundance by affecting the activities and rates of development of all stages of Lepidoptera, the activities of the natural enemies, and the rates of development of the food-plant" and "reductions in breeding and egg-laying activities that follow reductions in activities caused by unfavourable temperatures can result in scarcities or extinctions" (Beirne, 1955); for example, *A. urticae* was nearly extirpated in north-east England after the bad summers of 1902 and 1903, and at Oxford in 1918. Nevertheless, despite some correlations, the onset of warmer Springs in 1918 had been preceded by the spread of the butterfly into nearly half a dozen counties and the cold June's of the 1920's when the species was rapidly spreading shows that the weather over the second quarter of the year was not singularly or even primarily responsible for the distributional fluctuations under review; but not surprisingly, there is some evidence that low temperatures during this period did at least contribute to short term numerical variations.

Long term Winter temperatures (December/January/February) played a larger part in the territorial fluctuations of this insect. The lowest decadal average Winter temperatures recorded in this country since 1790 came during the first two decades of the 19th century; this coincides precisely with the butterfly's decline in southern counties and with Stephens observation of recent widespread scarcity, made in 1828. Similarly, the highest of these temperatures recorded during the 19th century came during the 1850's

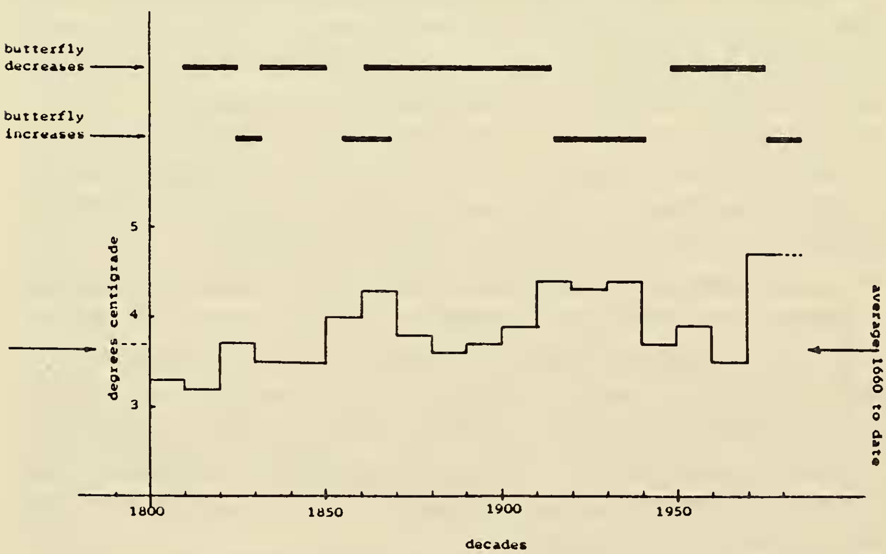

Fig. 1 Mean decadal central England winter temperatures 1800 – date with territorial fluctuations of *P. c-album* (from Manley, 1974, and Central Statistical Office, 1985).

and 1860's; this coincides precisely with the increase in distribution in northern counties. The worst period of sequentially cold winters since the early 19th century took place over the late 1880's and early 1890's (1886-1888, 1891-1893 inclusive) and a large number of county-wide declines and extinctions took place at this time. During this century there was a dramatic increase in these temperatures after 1909 lasting until the second world war, resuming again after 1970; the change was so great that the highest half decade temperatures since the 1730's were recorded. The trend can also be illustrated by the number of warm winters; excluding 1917, there was a unique period of sequentially warm winters from 1910 to 1927 and, excluding 1934, 1936 and 1979, from 1930 to 1939 and from 1971 to 1984 inclusive; again, this coincides well with the distributional fluctuations of the butterfly documented earlier – even down to one of the temporary halts during the 1930's.

The evidence suggests that a significant *alteration* in long term winter temperature trend predominently affects distribution, rather than variations around a particular temperature value; this would explain the fact that the Comma's widest distribution ever, within recorded entomological history, was recorded during the early 19th century (being almost equalled in about 1870); this peak was preceded by a century which contained only two decades of above average (1660 to date) winter temperatures, the 1740's and 1790's . . . . or did the expansion of commercial hops into Scotland and elsewhere over the last quarter of the 18th century introduce *c-album* with it? At any event, those published comments that exist from such an early era at least confirm that the species was not thought to be a particularly common one in many places away from its hop-gardened heart-lands, especially when compared to nowadays, despite the more northerly range – see map 1.

It is noticable that it takes a minimum of three to five years of a consistent and substantial change in these temperatures for territorial alterations to occur, or at least be large enough to be recognised, but a decade is the most applicable period.

It could be expected that the areas where *c-album* successfully took refuge were those that enjoyed warmer winters. The butterfly almost certainly survived in the Oxford district, within an outcrop of hop-gardens, and detailed local 19th century temperature records have been published (Lewis, 1937); analysis shows that the winter temperatures recorded consistently exceeded those calculated for central England (Manley, 1974) during the same period by about three degrees F.

There is a short period of apparent anomaly during part of the 1860's, where both increases and decreases in territory were noted; however, the former were reported from the north and the latter were all south of Liverpool.

"The mortality of insects caused by winter cold is probably the main factor controlling the abundance of most insects in temperate latitudes" and "the northward distribution of insects in the Northern hemisphere is often limited by the annual minimum temperature" (Uvarov, 1931). Furthermore, "populations of species that just reach the northern limits of their ranges in the British Isles have been affected detrimentally" (Beirne, 1955) by severe winter cold. But in this instance it was not minimum temperature that promoted fluctuation, rather a series of different temperatures over a number of years breaking from an established trend.

But this is not the end of the climatic coincidences. Examining the isopleths on a map of the average means of relative humidity (1921-1935) (Meteorological Office, 1952), there are only three areas in the British Isles which enjoy a relative humidity of below 75% during all three winter months – much of Aberdeenshire, a small portion of south Yorkshire, and by far the most extensive area, east of the Welsh mountains from the Severn Valley almost to the north coast. The first mentioned adjoins the most northern reports of *c-album*, parts of Yorkshire have always had an unusual affinity for the insect (the species hung on here in isolation until at least 1902, with a similar positive history in more modern times), and the remaining area coincides well with that of the Comma when at its lowest ebb. A penchant for low humidity would explain the species survival in the colder, but less humid, parts of Europe and the fact that the butterfly was usually much less frequent in our coastal districts; this especially applies to western areas as there is no 19th century record from Cornwall and the insect was loath to colonise the west-facing Welsh coast. In Finland high frequency butterfly years are accompanied by an average drop in humidity of 14% (Ekholm, 1975). However, it is known that an increased westerly air flow took place in this country over the first half of this century starting in 1896, dramatically increasing after 1902, and peaking in 1923 (Lamb, 1965); being of a more humid character, this would seem to limit speculation from this quarter – at least as a singular factor – unless detrimental humidity levels were already attained during our more average winters, the combination with cold bringing the deleterious effect into play. Still, the insect retreated to, and survived almost exclusively in, refuges containing the lowest winter humidity in the country – the largest and southern-most also coinciding with the distribution of commercial hops (Kent apart).

That the primary decline in distribution of *c-album* was caused by climate, as opposed to the loss of hop, is demonstrated by the otherwise inexplicable early 19th century decline in the south-eastern hop-gardens and elsewhere along the south coast.

Thus at the times of the butterfly's main declines and increases in frequency and distribution there were differential climatic coincidences – and the evidence suggests that more than one seasonal variation was involved. The species distribution was primarily determined by long-term winter temperatures, which explains the losses during hibernation; whilst frequency in the shorter term was often detrimentally affected by low temperatures during the second quarter of the year, a time of known difficulty, which would have restricted numbers in the main autumnal flight by the limitation of the first brood – both of these factors being particularly prevalent over the latter years of the 19th century and just after.

Summary

Just after the middle of the 18th century the range of *c-album* reached at least as far north as county Durham and over the early years of the 19th century it enjoyed a distribution that reached as far as Edinburgh but by the middle years of that century the species had retreated from the north and declined in frequency in the south and east. Much territory was regained north of Liverpool after 1855, reaching a maximum in a return to Scotland in the very late 1860's. After about 1870 a much more serious retraction of range took place. This culminated in the butterfly being at its nadir in this country in 1913. The insect commenced a revival during the following season that eventually resulted in much, but not all, of its former distribution being regained – reaching another maximum in the middle years of this century. From that time until the mid 1970's another decline in northern distribution took place, accompanied by a drop in frequency in many other counties. In the mid 1970's another expansion of range commenced which has continued until the present time (1985).

All stages of *c-album* are unusually affected by temperature and the foremost causes of fluctuation were climatic. The most powerful was that of long-term winter trends and sequences, which coincided with territorial fluctuations – higher temperatures gains, lower temperatures losses; low temperatures during the second quarter of any year also often coincided with low numbers.

Prior to this century the history of the Comma in this country was intimately bound with that of commercial hop-growing; the decline in acreage outside of the prime counties over the first three-quarters of the 19th century and its sudden collapse in distribution during the 1870's, and later, significantly contributed to the synchronous decline suffered by *c-album*. In addition, increasingly efficient insecticidal sprays commenced in general use on hops after 1883 and this, and other practices, further limited the num-

bers of all lepidopterous larvae successfully reaching maturity on the plant. Nevertheless, the insect almost exclusively retreated in distribution to those counties in, and adjacent to, those where hops were still farmed, these being the areas of lowest winter humidity. There is considerable documentary evidence gained from extensive field experience, to suggest that at around the turn of the century, due to changes in hop culture, the butterfly's primary foodplant changed from hop to stinging nettle.

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Notes and Observations

A PRODUCTIVE OAK IN A S.E. LONDON WOOD. – In the eastern portion of Oxleas Woods SSSI at Shooters Hill (over whose fate, alas, the proverbial sword of Damocles now hangs) there stands a fine oak, massive, spreading, and still vigorous. On 30th October 1984 this tree was found to have, on one side of its trunk, a number of smallish sap-runs, tending to coalesce into a diffuse sappy area much frequented by wasps and mostly small Diptera. The latter were few in species – I need mention only *Dryomyza anilis* Fall., whose numbers reached a peak on 11th November. It was the Coleoptera that proved unexpectedly interesting, in quality if not in quantity. To obtain them, however, was far from easy owing to the effort needed to prise off small pieces of the thick, extremely tough and tenacious bark, under and between which the beetles were to be found half hidden by sappy accumulations. A few also were sifted out of debris at the foot of the tree where a little sap had penetrated. They were (omitting species of no particular note):–